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for it, remember that in science the future is richer than the past. Valuable as have been the treasures extorted from reluctant Nature, those yet to be rifled from her storehouse will far surpass them. Be one of those who, like Sir JOHN HERSCHEL and his two friends, recorded a vow to "do their best to leave the world wiser than they found it."

HARVARD COLLEGE OBSERVATORY ASTRONOMICAL EXPEDITION TO PERU.

By MRS. M. FLEMING.

It is impossible at any one spot on the surface of the earth to establish an observatory at which all the stars in the sky can be observed. Even at the equator where all stars are visible, accurate measures could not be obtained of the stars in the vicinity of the poles since they are too near the horizon. Thus at the Harvard College Observatory while the horizon is in declination —47° 37′, stars south of —30° cannot be satisfactorily measured, neither can good photographs of them be obtained. Several important investigations which are described below having been undertaken at Cambridge and satisfactorily completed for the northern heavens, it was considered of great importance that these researches should be extended to the southern sky. Plans were therefore made for an auxiliary observing station in the southern hemisphere, and they have finally resulted in the erection of a collection of buildings, consisting of a dwelling-house for the observers, and various shelters for the different instruments, about three miles northwest of Arequipa, Peru, at an elevation of about 8000 feet. Here all arrangements have been made for extending to the south pole the researches begun at Cambridge.

The results of the first investigation undertaken as a memorial to Dr. HENRY DRAPER are contained in the H. C. O. *Annals*, Vol. XXVI, part I and Vol. XXVII. The first of these volumes contains a catalogue of the photographs of the stars taken at Cambridge and at Willows, California, and a discussion of the results of the measures made from these plates. The measures themselves form the DRAPER Catalogue of Stellar Spectra and are contained in Vol. XXVII. The photographs were taken with the BACHE telescope whose objective is a photographic doublet having an aperture of eight inches and a focal length of forty-five inches. A prism having a refracting angle of 13° was placed in front of the objective and thus the spectra of all stars in the field of the telescope were obtained on the photographic plate. The plates used were the most rapid 8 x 10 SEED plates, and each plate covered a region 10° square. Nearly the entire sky north of —30° was photographed here, four different investigations having been undertaken with the above-named instrument. *First*, chart plates having 10^{m} exposure; *second*, chart plates having 60^{m} exposure; *third*, spectrum plates having 10^{m} exposure; and, *fourth*, spectrum plates having 60^{m} exposure. The spectrum plates having 10^{m} exposure were those measured for the DRAPER Catalogue. They show the spectra of nearly all the stars brighter than the sixth magnitude. When the last two investigations mentioned above were nearly completed the instrument was removed to California, where it was mounted at Willows and used in photographing the Solar eclipse of January 1, 1889. The photographs obtained with the BACHE telescope in the northern hemisphere being so satisfactory, it was decided that the investigations undertaken with it should be extended to the south pole. Accordingly, in the spring of 1889, an expedition under the direction of Mr. S. I. BAILEY, started for Peru. Owing to the scarcity of wood in that country two frame houses were constructed here, one for the shelter of the instruments, the other for the observers. These were successfully erected on a mountain (since then known as *Mount Harvard*) about 6500 feet high, near Chosica, and about twenty miles east of Lima, Peru. The observers were thus almost entirely cut off from communication with the world below, and all supplies, even including water, had to be carried by mules from the valley below, a distance of about eight miles. The photographic work at this station was similar to that of the Cambridge station, except that the portion of the heavens to be photographed was from — 20° to the south pole. In other respects the plans for the four investigations described above were the same. The weather proved entirely satisfactory during the first six months. Fogs and clouds which often covered the adjacent valleys and the city of Lima did not reach to the top of the mountain. About thirteen hundred photographs were obtained and each of the four principal researches described above was one-half completed. The rainy season then set in, and during it the observers visited other points of the coast, going as far south as Valparaiso, to look for a better location. After visiting many different places they decided that the climatic conditions at Arequipa, which is situated on the Mollendo railway, at an elevation of about 7500 feet, were the most favorable for the continuation of the work planned for the southern station.

In addition to the photographic work another investigation was conducted at the station on Mount Harvard. All the stars north of — 30° of the magnitude 6.0 and brighter, as also the stars brighter than the tenth magnitude used for comparison with variables, and the zones used in the photometric revision of the *Durchmunsterung* were measured at Cambridge with the meridian photometer. When Mr. BAILEY went to Peru he took this instrument with him in order to extend the above investigations to the south pole. He obtained 217 series of observations containing 98,756 photometric comparisons of about 8000 southern stars. This work, together with the results published in Vol. XIV and XXIV, will furnish photometric magnitudes of stars as bright as the ninth magnitude in all parts of the sky. The stars selected for measurement in Peru include all those of the sixth magnitude and brighter south of — 30° and all known stars in a series of zones 20′ wide at intervals of 5° in declination from — 25° to — 80°, also all known stars south of — 80° and a miscellaneous list of variables, etc. The reduction of these observations is nearly completed and their publication will be begun shortly. While looking for a better location for the southern station, Mr. BAILEY took with him the meridian photometer, and obtained some valuable observations with this instrument at Pampa Central, in the Desert of Atacama, which was selected for the dryness of its climate. In October, 1890, the instruments on Mount Harvard were again dismounted and conveyed to Arequipa.

Photographs of planets, double stars, clusters, nebulæ and other objects of special interest had meanwhile been obtained with the 13-inch BOYDEN telescope at Cambridge and at Mt. Wilson in Southern California. Another expedition was accordingly planned which provided for the removal to Arequipa of this telescope with several smaller instruments. On December 20, 1890, Professor WM. H. PICKERING sailed from New York for Arequipa, Peru, accompanied by his assistants, Mr. A. E. DOUGLAS and Mr. R. D. VICKARS. They joined Mr. BAILEY at Arequipa, Professor WM. H. PICKERING assuming charge of the station while Mr. BAILEY, having completed his observations with the meridian photometer, returned to Cambridge, bringing with him that instrument and leaving the BACHE photographic telescope where it is still used in completing and extending the investigations described above. Very favorable accounts of the atmospheric conditions at this station have been received. The sky is nearly cloudless during the greater part of the year, the air is remarkably steady, the images of the stars are small and round, and even using high powers, the fluctuations of the images are very slight. Several diffraction rings are visible around the brighter stars. They are rarely seen at Cambridge with so large an instrument. Therefore, at this station, the limit of observation will depend on the size of the instrument used instead of, as at other observatories, the condition of the air. It therefore seems to be of great importance to astronomy to have at this station a large and powerful telescope, one which would give results for the southern heavens, which would be comparable with those of the northern heavens, obtained with the LICK telescope. The BOYDEN telescope has an aperture of only thirteen inches, and yet it is apparently the largest refracting telescope in use in the southern hemisphere, or in fact south of + 35°. In addition to the study of the objects of special interest mentioned above, a plan has been made for photographing with this instrument, the spectra of all the brighter stars in the southern heavens by placing in front of the object-glass one of the prisms which was formerly used with the 11-inch DRAPER telescope. Photographs have been obtained at Arequipa showing the extreme ultra-violet lines including a series of lines or bands of even shorter wavelength. Thus the detailed study and classification of the brighter stars, also, will be extended to the South Pole. In fact, almost all the more important investigations undertaken at Cambridge are, by means of this valuable auxiliary station, being rapidly extended from pole to pole. Meteorological instruments are in operation at this station and will furnish interesting records of atmospheric conditions prevailing at this elevation. A series of meteorological observations at Vincoucaya, elevation 14,600 feet; at Peru, elevation 12,500 feet; and at Mollendo, near the sea level, have also been obtained. An ascent of El Misti, which has an elevation of 18,600 feet, was made by Professor WM. H. PICKERING.

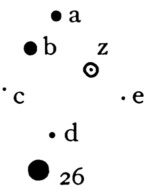
Another interesting expedition was that to *Tiahuanuco* and the sacred islands of Incas, on lake *Titicaca*, which led to results of much archæological interest. Important aid has been rendered to the expedition by many residents in Peru without whose assistance the establishment of the station would have been extremely difficult.

HARVARD COLLEGE OBSERVATORY,
CAMBRIDGE, MASS., February 19, 1892.

ASTRONOMICAL OBSERVATIONS.

Made by TORVALD KÖHL, at Odder, Denmark, in the year 1891.

Z Cygni.



The region near the star 26 *Cygni* has been reviewed. December 7, 1890, the star Z appeared as bright as a, but it very rapidly decreased, so that on

January 1 : $Z < c$.
" 6 : id.
" 9 : id.
February 4 : Z invisible in the 3-inch STEINHEIL, power 42.
" 13 : id.
" 27 : id.
August 26 : $Z = b$.
" 30 : id.
September 4 : $a > Z < c$.
" 8 : $Z = c$.
" 23 : $Z < c$.
" 29 : $Z = e$.
October 26 : Z invisible.
November 5 : $Z < e$, extremely faint.
" 28 : id.